APPENDIX: DATA ACQUISITION SOFTWARE

The measurement system uses software developed by the Institute for Telecommunication Sciences (ITS) to control all measurement system functions via computer. This control program, called Data Acquisition (DA), runs on any DOS-based computer with sufficient memory. It interfaces with the measurement system via general-an IEEE-488 bus at rates limited only by the computer's operating speed and functional speed of the managed hardware (interfaces, switches, components, etc.). DA will support any available combination of RF front-ends, spectrum analyzers, and auxiliary analysis equipment.

The DA program is basically four control subroutines that direct operation of multiple subroutine kernels that in turn control every function of the measurement system. This appendix includes descriptions of the three control subroutines used for the railroad land mobile radio measurements (receiver algorithm, spectrum analyzer, and RF front-end) and the resultant system functions. As DA program development continues to meet new measurement demands, these functional descriptions may change with time.

1. RECEIVER ALGORITHM SUBROUTINE

The DA receiver algorithm subroutine provides software management for up to 32 measurement algorithms (called program kernels in DA or band events). Any one of these algorithms, when coupled with spectrum analyzer and front-end selections (described later in this appendix), becomes a customized measurement system for receiving certain signals or signal types. Because the characteristics of emitters and the requirements for data on those emitters vary considerably, many different algorithms have been developed. However, all of the algorithms are based upon either a frequency sweep across the spectrum of interest, or a series of discrete steps across that spectrum. Since the railroad land mobile radio measurements used only the swept mode, the stepped mode is not discussed below.

> **Swept:** This algorithm controls a conventional spectrum analyzer[1] sweep across a selected portion of spectrum. Any type of detection available in the analyzer (i.e., positive peak, sample, etc.) can be used. Repeated sweeps may be programmed, and multiple sweeps incorporating the maximum-hold spectrum analyzer mode may also be performed. This algorithm also allows for sweeping a spectral band in several sub-bands (scans). This feature is important if a narrow bandwidth (e.g., 10 kHz) must be used to measure a spectral band that is more than 1000 times the width of the measurement bandwidth, e.g., measuring 900-930 MHz with a 10-kHz bandwidth requires at least three scans to ensure no loss of data.

[1] For spectrum surveys and most operations with DA software control, any IEEE-488 interfaced spectrum analyzer that processes at least 1000 points (frequencies) per display sweep may be used.

1.1 Receiver Parameters

The following are brief descriptions of the DA program input parameters needed to run the above subroutines (algorithms).

Start and Stop Frequencies: The value in MHz of the first and last frequency point to be measured. These numbers must be equal to or fall outside the event frequency band range.

Sweeps: The number of sweeps in each scan. DA processes each sweep so increasing this number can add greatly to measurement time; however, increasing this value also increases the probability of intercept for intermittent signals.

2. SPECTRUM ANALYZER SUBROUTINE

The DA spectrum analyzer subroutine manages configuration control strings (via the IEEE-488 bus) for the spectrum analyzer. The operator selects spectrum analyzer parameters (listed in the following subsection) from menus in the DA program. Generally, parameters are selected that will configure the analyzer to run with a receiver algorithm for a desired measurement scenario. DA protects against out-of-range and nonlinear configurations but the operator can control the analyzer manually for unusual situations.

2.1 Spectrum Analyzer Parameters

When the DA program sends command strings to the analyzer, all signal path parameters are reset according to the operator selections for the measurement scenario. The following are brief descriptions of the analyzer parameter choices controlled by DA.

Attenuation: May be adjusted from 0-70 dB in 10-dB increments. The spectrum analyzer subroutine determines whether or not measurement system front-end attenuators are available and if so will set them to the selected value. Spectrum analyzer attenuation is set to zero when measurement system attenuation is active, if however, measurement system attenuators are not available the spectrum analyzer attenuation will be set to the selected value.

IF Bandwidth: May be selected from 0.01-3000 kHz in a 1, 3, 10 progression.

Detector: Normal, positive peak, negative peak, sample, maximum hold, and video average modes are available.

Video Bandwidth: May be selected from 0.01-3000 kHz in a 1, 3, 10 progression.

Display: Amplitude graticule choices in dB/division are: 1, 2, 5, and 10. This parameter selection applies to both the analyzer and the system console displays.

Reference Level: May be adjusted from -10 to -70 dBm in 10-dB increments.

Sweeps: Number of analyzer processed sweeps per scan. This parameter is only used with maximum hold or video averaged detection.

Sweep Time: This parameter (entered in seconds) specifies sweep (trace) time if used with swept algorithms, or specifies step-time (dwell) if used with a stepped algorithm.

3. RF FRONT-END SUBROUTINE

The DA software handles the RF front-end path selection differently than other routines. Most of the RF-path parameters are predetermined by the measurement algorithm so operators need only select an antenna and choose whether preamplifiers are turned on or off. Preselection is also controlled by the antenna selection.

The antenna selection is made from a list of antenna choices that is stored in a separately maintained library file called by the RF Front-end Subroutine. Antenna information stored in the file includes:

- antenna type (omni, cavity-backed, etc.);
- manufacturer (may include identification or model number);
- port (tells the computer where signals enter the measurement system and includes particulars on any external signal conditioning such as special mounting, additional amplifiers, or extra path gain or loss);
- frequency range;
- vertical and horizontal beam widths;
- dB gain;
- front to back ratio; and
- side lobe levels.